Lateral tensions and pressures in membranes and lipid monolayers

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Abstract

The effects of lateral tension on the properties of membranes are often explained in comparison with analogous experiments on monolayers, which yield more detailed data. To calculate the effects of changes in tension on the composition of, or incorporation of amphiphiles into membranes we examine (i) the fidelity of the monolayer analogy, (ii) the range of possible tensions in a membrane, and the way in which tensions arise and (iii) the equilibrium partitioning of amphiphiles between aqueous solution and a bilayer under tension. We argue that, at the same areas per molecule, a monolayer at an n-alkane/water interface is a closer analogy of the lipid bilayer than a monolayer at an air/water interface. Next, we show from a thermodynamic argument that changes in membrane tension can affect the absorption of very large amphiphiles such as proteins, but that physiological tensions are unlikely to affect the absorption of lipids or drugs. Finally we consider the possibility that the measured bulk tension in a complicated membrane such as that of the erythrocyte may be larger than the local tension in the fluid mosaic portions, and suggest a model which explains the ability of the erythrocyte membrane to withstand much higher tensions than other biological membranes and lipid bilayers.

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